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Entitled

DESIGN OF GRAPHENE BASED SENSORS FOR NUCLEIC ACIDS DETECTION AND ANALYSIS

by

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Abstract

DNA (deoxyribonucleic acid) is the blueprint of life as it encodes all genetic information. In genetic disorder such as gene fusion, copy number variation (CNV) and single nucleotide polymorphism, Nucleic acids such as DNA bases detection and analysis is used as the gold standard for successful diagnosis. Researchers have been conducting rigorous studies to achieve genome sequence at low cost while maintaining high accuracy and high throughput. Quick, accurate, and low cost DNA detection approach would revolutionize medicine. Genome sequence helps to enhance our perception of inheritance, disease, and individuality. This research aims to improve DNA bases detection accuracy, efficiency, and reduce the production cost, thus novel based sensors were developed to detect and identify the DNA bases. This work aims at first to develop specialized field effect transistors which will acquire real time detection for different concentration of DNA. The sensor was developed with a channel of graphite oxide between gold electrodes on a substrate of silicon wafer using Quantumwise Atomistix Toolkit (ATK) and its graphical user interface Virtual Nanolab (VNL). The channel was decorated with trimetallic nanoclusters that include gold, silver, and platinum which have high affinity to DNA. The developed sensor was investigated by both simulation and experiment. The second aim of this research was to analyze the tissue transcriptome through DNA bases detection, thus novel graphene-based sensors with a nanopore were designed and developed to detect the different DNA nucleobases (Adenine (A), Cytosine (C), Guanine (G), Thymine (T)). This research focuses on the simulation of charge transport properties for the developed sensors. This work includes experimental fabrication and software simulation studies of the electronic properties and structural characteristics of the developed sensors. Novel sensors were modeled using Quantumwise Atomistix Toolkit (ATK) and its graphical user interface Virtual Nanolab (VNL) where several electronic properties were studied including transmission spectrum and electrical current of DNA bases inside the sensor's nanopore. The simulation study resulted in unique current for each of the DNA bases within the nanopore. This work suggests that the developed sensors could achieve DNA sequencing with high accuracy. The practical implementation of this work represents the ability to predict and cure diseases from the genetic makeup perspective.

Keywords: Nucleic acid detection, DNA bases detection, graphene, graphite oxide, nanoribbons, nanopore, electronic transport, nanoclusters, field effect transistor.